

WHAT IS CLAIMED IS:

1. A method of detecting a chemical analyte in a fluid,
comprising:

providing one or more sensors comprising regions of conductive material and regions of nonconductive material proximate to the conductive material, the nonconductive material including one or more chemical groups coupled to the conductive material, the chemical groups being displaceable by a chemical analyte;

exposing the sensors to a fluid containing the chemical analyte under conditions sufficient to cause the chemical analyte to displace one or more of the chemical groups;

measuring a response based on the displacement of the chemical groups; and

detecting the chemical analyte based on the measured response.

2. The method of claim 1, wherein:

the conductive material includes a plurality of particles.

3. The method of claim 2, wherein:

the particles include one or more metals.

4. The method of claim 2, wherein:

the particles include a metal core; and

the chemical groups include one or more ligands

covalently coupled to the metal core.

5. The method of claim 4, wherein:

the chemical analyte is a thiol;

the metal core includes gold or silver; and

the chemical groups include an alkylamine.

6. The method of claim 4, wherein:

the particles are disposed in a polymer matrix.

7. The method of claim 6, wherein:

the polymer matrix includes a conducting, semiconducting,

or insulating organic polymer.

8. The method of claim 1, wherein:

measuring the response includes measuring a change in conductivity, resistance, impedance, capacitance, inductance, or optical properties of one or more of the sensors, or a

combination thereof, upon exposure of the sensors to the chemical analyte.

9. The method of claim 4, wherein:

the chemical analyte has a size that is smaller than a size of one or more of the chemical groups; and measuring the response includes measuring a decrease in resistance or an increase in conductivity resulting from displacement of the chemical groups by the chemical analyte.

10. The method of claim 1, wherein:

the nonconductive material includes a plurality of chemical groups coupled to the conductive material.

11. The method of claim 10, wherein:

the plurality of chemical groups includes a plurality of different chemical groups.

12. The method of claim 10, wherein:

the sensors are exposed to the fluid containing the chemical analyte under conditions sufficient to cause the chemical analyte to displace a first portion of the plurality of chemical groups, such that the conductive material remains

coupled to one or more remaining portions of the plurality of chemical groups;

the method further comprising detecting a second chemical analyte by exposing the sensors to a fluid containing the second chemical analyte under conditions sufficient to cause the second chemical analyte to displace one or more remaining portions of the plurality of chemical groups, measuring a response based on the displacement of the one or more remaining portions of the plurality of chemical groups, and detecting the second chemical analyte based on the measured response.

13. The method of claim 12, wherein:

the second chemical analyte is the same as the chemical analyte.

14. The method of claim 12, wherein:

the second chemical analyte is different from the chemical analyte.

15. The method of claim 1, wherein:

the sensors include a plurality of different sensors.

16. The method of claim 15, wherein:

the plurality of different sensors form a sensor array.

17. The method of claim 16, wherein:

the sensor array includes two or more sensors each including a different conductive material.

18. The method of claim 16, wherein:

the sensor array includes two or more sensors each including a different chemical group.

19. The method of claim 16, wherein:

detecting the chemical analyte based on the measured response includes identifying the chemical analyte based on a different response measured for each of a plurality of the different sensors.

20. The method of claim 4, wherein:

the metals include one or more of Ag, Au, Cu, Pt, Pd, Ni, W, Rh, Cr and alloys and mixtures thereof.

21. The method of claim 4, wherein:

the ligands include one or more members selected from the group consisting of alkylamines, alkanethiols, phosphines, carboxylates, thiolates, nitriles, sulfonates and surfactants.

22. A method for detecting a chemical analyte in a fluid, comprising:

providing one or more sensors comprising a plurality of conductive particles disposed in a nonconductive matrix, the conductive particles comprising a metallic core;

exposing the sensors to a fluid containing the chemical analyte under conditions sufficient to cause the chemical analyte to react with the metallic core to form a capped particle;

measuring a response based on the reaction of the chemical analyte and the metallic core; and

detecting the chemical analyte based on the measured response.

23. An apparatus for detecting a chemical analyte in a fluid, the apparatus comprising:

one or more sensors operably connected to a measuring device, at least one of the sensors comprising regions of conductive material and regions of nonconductive material

proximate to the conductive material, the nonconductive material including one or more chemical groups coupled to the conductive material, the chemical groups being displaceable by a chemical analyte, each of the sensors defining a response path through the regions of conductive material and nonconductive material; and

a measuring device operably connected to the sensor array, the measuring device being configured to measure a response upon exposure of the sensor array to a chemical analyte.

24. The apparatus of claim 23, wherein:

the conductive material is covalently coupled to the nonconductive material.

25. The apparatus of claim 24, wherein:

the conductive material includes a particle comprising an organic material, an inorganic material or a mixed inorganic-organic material.

26. The apparatus of claim 25, wherein:

the particle has a core comprising a metal, a metal alloy, a metal oxide, an organic complex, a semiconductor, a superconductor or a mixed inorganic-organic complex.

27. The apparatus of claim 26, wherein:

the core includes one or more metals or metal alloys.

28. The apparatus of claim 27, wherein:

the one or more metals are members selected from the group consisting of Ag, Au, Cu, Pt, Pd, Ni, W, Rh, Cr and mixtures and alloys thereof.

29. The apparatus of claim 28, wherein:

the metals include Au.

30. The apparatus of claim 23, wherein:

the nonconductive material includes one or more ligands.

31. The apparatus of claim 30, wherein:

the ligands include one or more members selected from the group consisting of alkylamines, alkanethiols, phosphines, carboxylates, thiolates, nitriles, sulfonates and surfactants.

32. The apparatus of claim 31, wherein:

the ligands include decylamine or dodecylamine.

33. The apparatus of claim 23, wherein:

the particle includes a gold cluster coupled to one or more organic ligands.

34. The apparatus of claim 23, wherein:

the measuring device is an electrical measuring device.

35. The apparatus of claim 23, wherein:

the response includes a change in conductivity, resistance, impedance, capacitance, inductance, or optical properties of the sensor, or a combination thereof.

36. The apparatus of claim 23, wherein:

the sensors include a plurality of different sensors.

37. The apparatus of claim 36, wherein:

the plurality of different sensors form a sensor array.

38. The apparatus of claim 37, wherein:

the sensor array includes two or more sensors each including a different conductive material.

39. The apparatus of claim 37, wherein:

the sensor array includes two or more sensors each including a different chemical group.

40. The apparatus of claim 37, wherein:

the measuring device is configured to measure an aggregate response based on a plurality of responses from a plurality of the different sensors in the sensor array upon exposure of the sensor array to a chemical analyte.

41. The apparatus of claim 23, wherein:

the conductive material includes a plurality of particles.

42. The apparatus of claim 41, wherein:

the particles include one or more metals.

43. The apparatus of claim 41, wherein:

the particles include a metal core; and

the chemical groups include one or more ligands covalently coupled to the metal core.

44. The apparatus of claim 43, wherein:

the chemical analyte is a thiol;
the metal core includes gold or silver; and
the chemical groups include an alkylamine.

45. The apparatus of claim 43, wherein:

the particles are disposed in a polymer matrix.

46. The apparatus of claim 45, wherein:

the polymer matrix includes a conducting, semiconducting, or insulating organic polymer.

47. The apparatus of claim 23, wherein:

at least one sensor of the one or more sensors is a surface acoustic wave sensor; a quartz microbalance sensor; a conductive composite; a chemiresistor; a metal oxide gas sensor; a conducting polymer sensor; a dye-impregnated polymer film on fiber optic detector; a polymer-coated micromirror; an electrochemical gas detector; a chemically sensitive field-effect transistor; a carbon black-polymer composite; a micro-

electro-mechanical system device; or a micro-opto-electro-mechanical system device.